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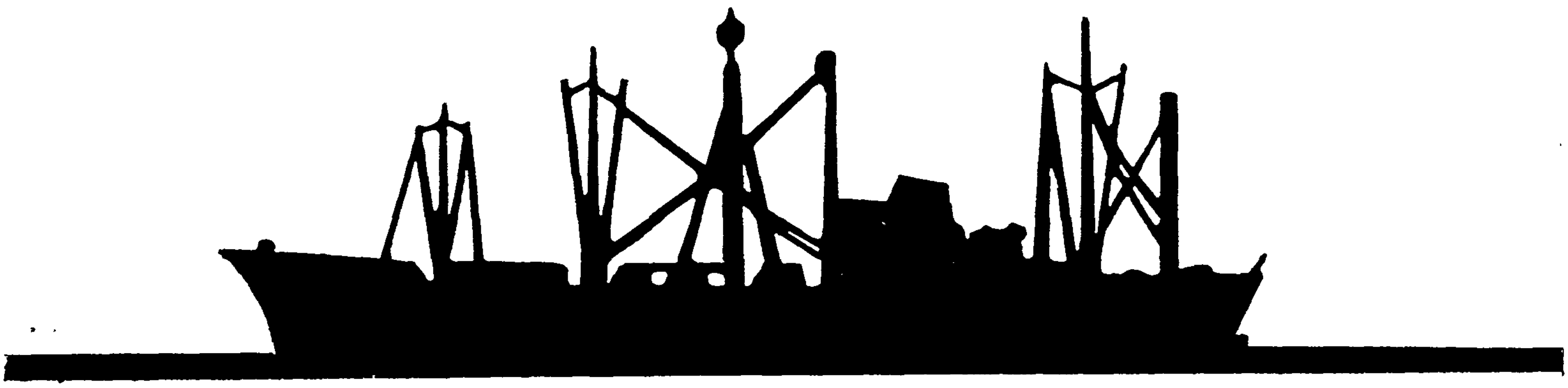

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

AN INTEGRATION APPROACH TO COMPUTER AIDED DESIGN SYSTEMS FOR SHIP DESIGN

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ABSTRACT

The use of Computer Aided Design (CAD) tools has become increasingly common in the ship design and manufacturing industries over the last decade. These tools have often evolved from small individual efforts developed by one or two engineers into major programs on which large portions of the ship design effort depend. In many cases the management of the computer system has not kept pace with the evolution of the software.

This paper describes an approach taken to the development of computer systems to minimize some of the resulting problems. The underlying premise is that the objective of the system is to increase the overall productivity of the organization instead of the productivity of any single technical discipline. The conclusions reached were that more consideration should be given to the data storage, management and communication capabilities of current computers by the ship design organizations in addition to the effort of developing design or analysis programs. The conceptual system design that resulted from applying this approach to a particular organization is presented along with a description of the first software item implementing this concept.

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The conclusions and opinions presented are those of the author and are not associated with the views of the Naval Sea Systems Command.

Section 1

INTRODUCTION

The use of Computer-Aided Design (CAD) technology has become a major part of the ship design and manufacturing projects. The programs being used have evolved from small simple routines to complex groups of programs that work together. The present trend is towards an increasing reliance on computer aids to the ship design process. These systems are expensive to implement and the resources for their development are usually limited. We are now faced with the task of planning and managing the further development of these aids to maximize the return on investment.

The technology to perform the separate pieces of a Itpaperless design", exists now, that is, designing a ship where the primary means of recording and manipulating the design is the computer system. There is potential for great improvement in ship design productivity, and hence profitability, with a paperless design" system. However, no system with all the separate pieces integrated into a unified system has yet been developed. Some factors responsible for this situation are the cost of such a system, and possibly the need for a different approach to their development. In particular, the management of ship design organizations must realize that the CAD systems are essential in the ship design efforts and that major productivity gains are possible through focusing management attention and resources on those systems.

This paper will discuss an approach used to help determine where computer technology development efforts may be focused to provide the greatest improvements in the productivity of the overall organization.

We will then briefly describe a study of a system where this approach was followed. A conceptual integrated system design reflecting the conclusions of that study will be described. The software efforts to develop the data management, data storage and communications capabilities of the computer system for CAD will be presented.

Section 2

APPROACH TO COMPUTER AIDED DESIGN SYSTEMS

This section presents the general approach SofTech has found useful in system design and analysis problems in both the Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) environments. The specific software developed may have limited applications. However, the approach may be found useful in tackling a wide variety of system productivity and profitability problems. Later sections will describe the results of applying this approach to a specific task.

2.1 Define the Organizational Objectives

The first step in the design of any system is to develop an understanding of the objectives of the organization that will utilize the system. This is a seemingly obvious step but surprisingly it is rarely accomplished.

Systems for Computer Aided Manufacturing may have relatively straight-forward objectives; for example, to double the production capacity of a factory. Computer Aided Design systems have not always lent themselves to consideration in the same fashion. It is not easy to define the productivity of a design organization, as the product is often not readily quantifiable. As a result, many times programs are developed without regard as to whether they will actually improve the productivity and profitability of the overall organization. So while it is technically feasible to perform a great many functions with current computers, the first step is to determine’ the criteria of the overall organization for the success of a computer system. The overall organization’s point of view in many cases is very different from that of the design engineers.

An analogy that may be useful is the visualization of the design organization, a collection of people, hardware and software, as a "black box" system. Resources are the inputs and designs are the outputs. The organizational objectives may be to increase these outputs while maintaining a constant level of resource inputs. (Figure 2-l).

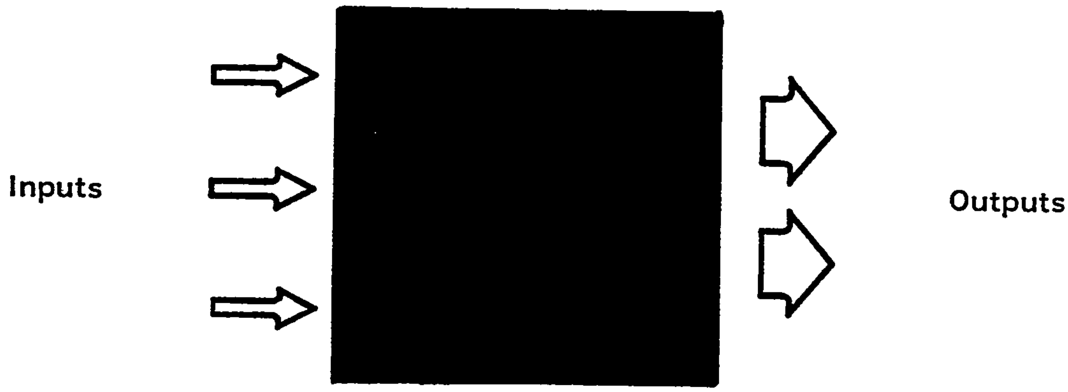

Figure 2-1. Black Box

The process of determining these objectives can be time consuming. SofTech usually conducts a series of interviews and reviews independently with the organization management. The number of implied, undocumented objectives or goals "discovered" during this process is often surprising and very useful to the managers.

2.2 Understand the System

Once the overall objectives are defined we can progress to analyzing the system. Through studying the system we can determine how components collectively produce the design as an output. We may also begin to identify problem areas.

There are often many people who will say that they understand exactly how their design process works. It is important to realize that each member of a design organization may have a different view of how the design is accomplished, and all may be equally correct. Each personnel role in the design system, engineer, manager, and administrator, has the potential for a different viewpoint of the system. The design process may consist of balancing tradeoffs to a design manager, while it is a process of calculations to a designer. We have found that oftentimes the viewpoint of the organizational manager is not known to those actually developing the CAD systems.

The process of learning a system is akin to developing a schematic of the inside of our previously mentioned "black box." (Figure 2-2).

That is, we develop an understanding of what paths and transformations internal to the system are necessary to develop the output of the system. We also learn what areas have a minimal impact on the factors we are interested in. In fact we may have to develop a different "schematic" for each viewpoint to really understand how the system functions.

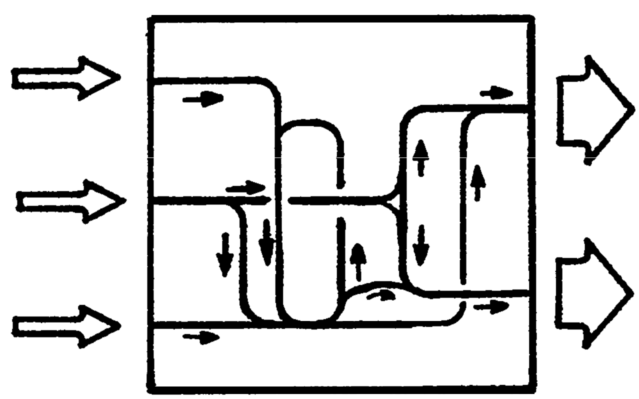

Figure 2-2. Understand the System

2.3 Identify Needs

When it is reasonably certain that the organizational objectives and the nature of the design or manufacturing process are understood, the "needs" of the system can be identified.

By the term "need" we mean a deficiency, bottleneck or problem in the process. If we think of the design process as a black box with a maze of interconnecting pipes linking the input to the output, the "need" would be the areas of restriction of the flow. These may be ‘blockages or malfunctions or other items that may be functioning properly but are of insufficient capacity. (Figure 2-3).

In many cases the “needs" of a system will be identified during the process of learning how the system works. It is important that we evaluate these "needs" on the basis of what we hope to accomplish. In our case it is to increase the overall design efficiency.

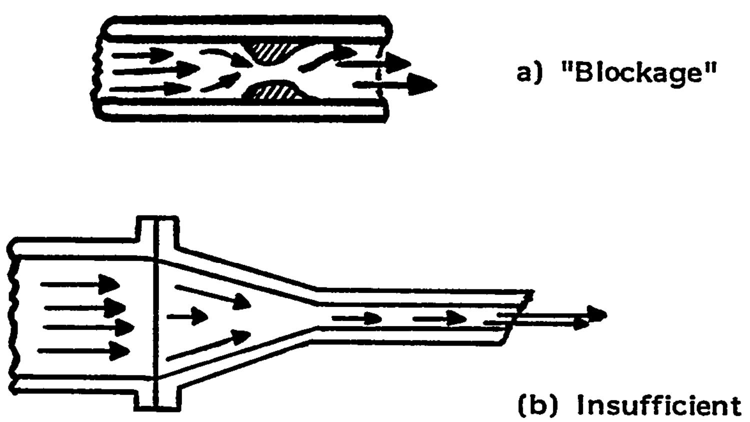

Figure 2-3. “Needs

2.4 Scoping the System

In most cases, there are more problems than resources available to solve them. Therefore, the "needs" must be prioritized based on the overall system objectives. In the analogy of the "black box" system only a number of the identified blockages can be improved. It is our job to determine which efforts will provide the greatest return on investment.

Management must take an active interest in this step of the process. There are limits to what can be accomplished with a fixed level of resources. Often, focusing the resources on one area may do more to improve productivity than attempting to apply an uniform effort to all the problems. At this time the management can often be made aware of how much their system can be improved with a functioning CAD operation.

2.5 Formulate Solutions

Once areas of the system in need are identified, an attempt can be made to formulate a solution to each one. This is much easier to talk about than to actually accomplish. Going back to our "black box" system analogy we have several choices.

If there is a “blockage," or malfunction of an item, we can possibly correct it.

If there is an area of insufficient capacity, we can enlarge the capacity of the existing unit.

The third possibility is to change the system configuration, i.e., reroute the flow or change the boundaries of the "box."

It is impossible to supply a formula for developing specific solutions. Many times the operational staff of the project can contribute a great deal to the development of solutions if a suitable forum is provided. Our (SofTech) tasks have often been to communicate the "fixes" envisioned by engineers to management.

2.6 Implement Solutions

Once the solutions are developed they may be subject to further changes due to cost, time constraints or a redefinition of the overall objectives. When these are finalized there remains the problems of implementation. The solution may be writing software, acquiring hardware, or reorganizing personnel in the design process. Each of these projects would now have their own approach to accomplishing a more defined set of detailed objectives.

2.7 Evaluation

Once the changes are made to the system they should be evaluated with respect to the defined organizational objectives.

"Did the items implemented accomplish the desired objective? And if not, why?"

The answer may be outside conditions impacting the system or a failure to fully understand the system and its problems. Establishing a record of the successes and failures and applying that knowledge to succeeding efforts is a valuable part of the process. This body of knowledge provides much of the background for determining the potential returns on items not easy to quantify.

Section 3

APPLICATION OF APPROACH TO NAVSEA 55

This section will describe the results of applying the presented approach to a task of improving design productivity of a specific ship design organization. The organization studied was the Naval Sea Systems Command (NAVSEA), Code 55, the Hull Design Group.

3.1 Organizational Objectives

In the particular project being discussed, the organizational objectives were stated as:

> "to achieve an increase in design productivity of better than five to one."

The reasons for establishing this objective are a predicted large increase in the ship design workload and the shortage of experienced, trained naval architects. Not only are there governmental personnel ceilings, but it is estimated that even if these limits were relaxed there are simply not enough trained engineers available nationwide.

Some secondary objectives were in fact constraints to the solutions. They are: the proposed improvements must be available soon; they must not disrupt the present ship design process; and of course, the cost must be minimal.

3.2 The NAVSEA Design Process

The engineering system studied was the Hull Design Group of the Naval Sea System's Command, Code 55.

This organization is responsible for defining the geometry, or envelope, of a ship. This includes the ship structure, internal and topside arrangements, stability, speed vs. power, etc. This group works closely with similar organizations having responsibility for weapons, electronics, and machinery. As can be seen from the following paragraphs it is fairly typical of a ship design organization.

3.2.1 Design Organization

The Hull Group, NAVSEA 55, organization is subdivided into smaller groups by a functional breakdown. Each organizational group is responsible for specific sections of the ship design. As an example, one group would be responsible for developing the ship's hull geometry. As a design progresses a task required in the geometry development will be assigned to an engineer. This engineer will generally continue to be responsible for this task throughout the many iterations of the ship design.

Periodically, the ship design will be ltissued.ll This means that the current state of the entire design at that point in time will be collected and approved as a ttbaseline.tt At these steps the engineers' supervisor will be responsible for the approval or "sign-off" of a drawing or a set of information. The aggregate of these approved drawings or information sets comprises the "design."

The engineer will start on the next iteration of his task using this "baseline" package. During iterations of the "baseline" the engineer will communicate, either formally or informally, with other designers to obtain more up-to-date information or information not collected into the formal "issue."

3.2.2 Current CAD Software

The "typical" engineer may perform one or two specific design tasks. If supported by the CAD system, these tasks will usually be performed by single batch-type programs, or stand-alone interactive programs. Programs of these types usually have defined format inputs, and defined format outputs. Where necessary, data translation is accomplished by "interface" routines. The design process is, therefore, a collection of individual programs and logically separate data items in the form of "files."

3.2.3 Hardware

The NAVSEA computer hardware environment includes a number of separate mainframe's and mini-computers. Included are IBM, CDC and DEC equipment "linked" via file transfer capabilities in a batch mode.

The user has remote access to these systems over dial-up phone lines, usually at 1200 baud. Terminals include TEKTRONIX 4014's, "Dumb" CRT's, and TTY type units.

3.3 Needs

The discussion of the "needs" of a design organization requires us to step back and examine the process from some distance.

A typical design organization may be as shown in Figure 3-1. The organization is a ordered assemblage of people, information and tools. The people may be design managers, administrators or engineers. The information consists of procedures, or how things are accomplished and data about the particular technical subject. The tools may be technical items such as computer and programs or more basic items like drafting supplies and services.

Obviously, a problem with any one of these areas can have a negative impact on productivity. We will only focus on those areas potentially suited for computer support, and in particular those related to the technical design information.

The elements of the design process that are most involved with the design information are shown in Figure 3-2. We have identified the engineer (circle), the manager (square), and information (triangles). Arrows show typical flows of information. The information needed for a design task includes procedures, historical data, the project data, and various stages of approved design data.

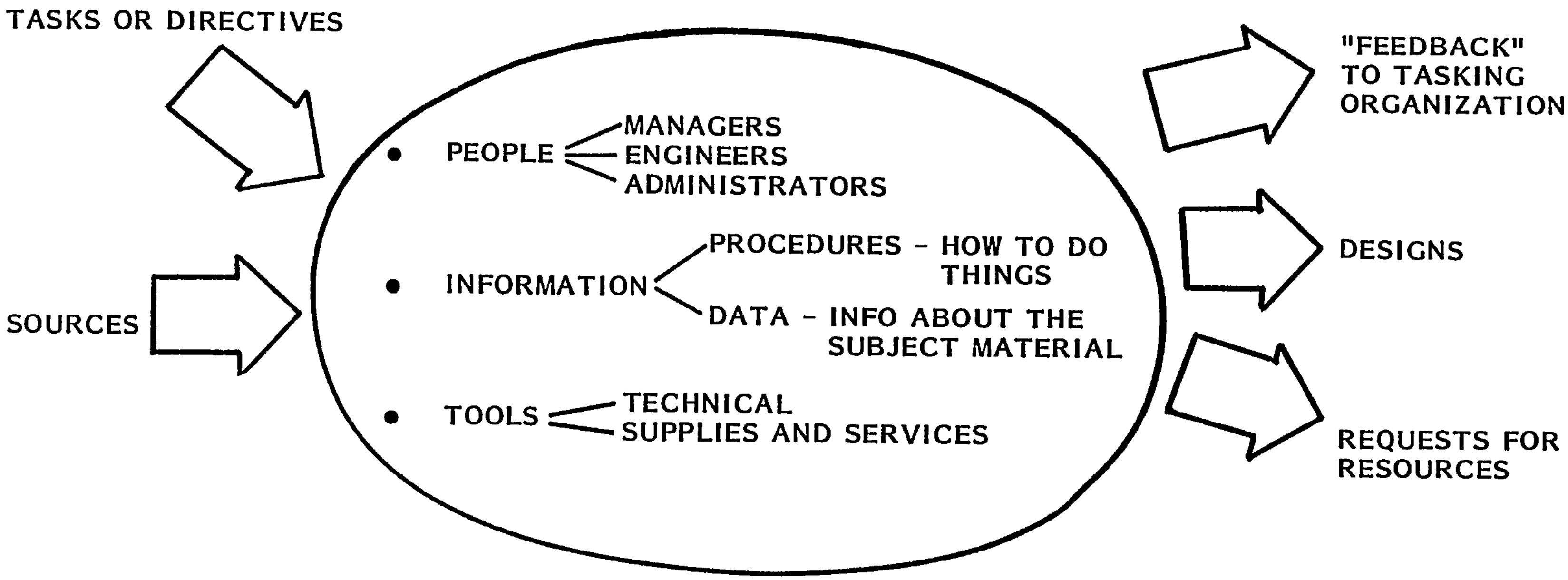

Figure 3-1. Design Organization

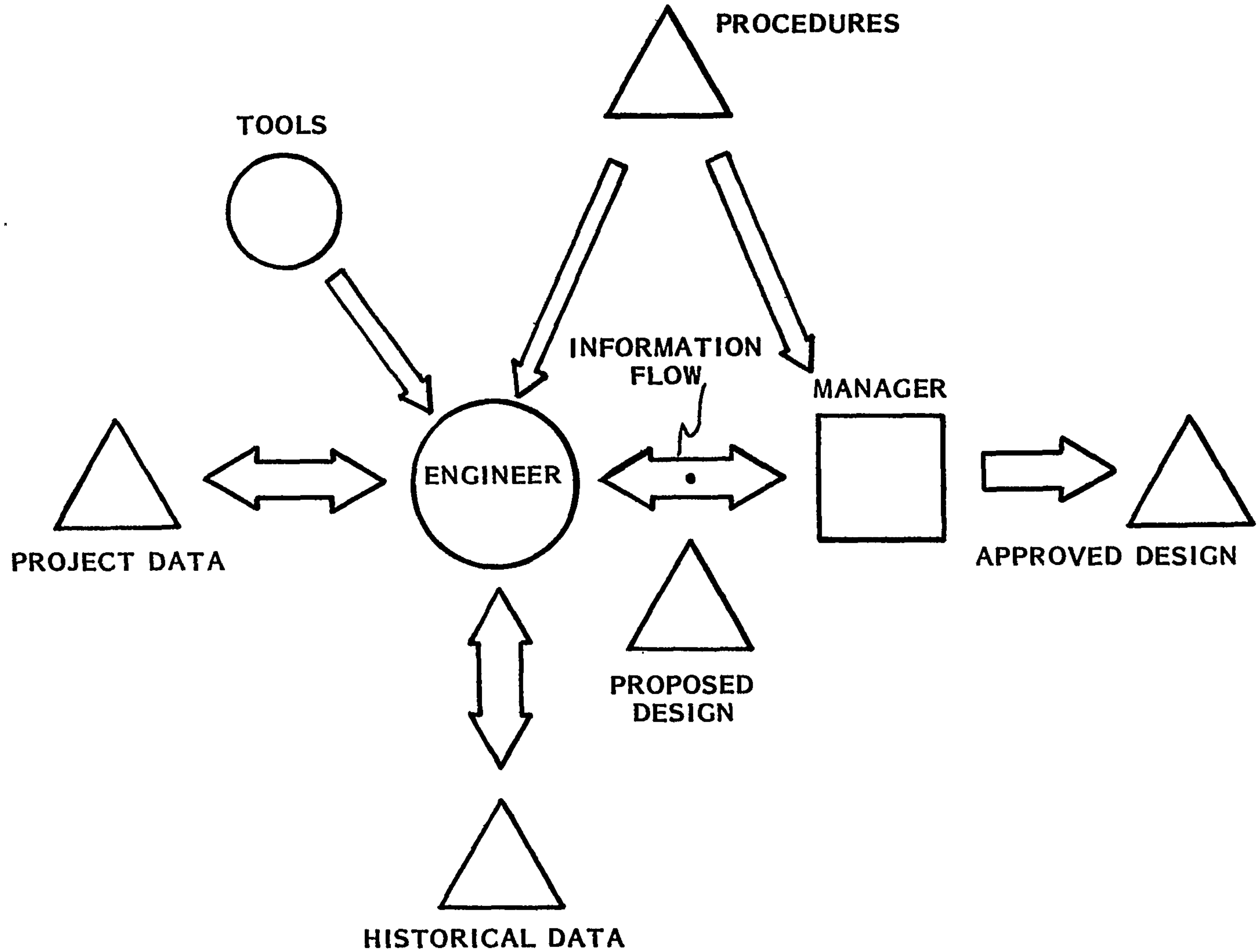

Figure 3-2. Elements of the Design Process

When considering a section of organization, we come up with the picture shown in Figure 3-3. More than one engineer is using information and there are a large number of data flows. Some of these information transfers are of the program-to-program type, but many more are informal or paper transmittals.

The evaluation of needs for this project was performed at the level shown in Figure 3-3. The question posed was: "What can be done to make this system of information derivation, transfer and approval work more efficiently?". The evaluation was accomplished by examining each of the elements of the design process other than the personnel.

3.3.1 Information "needs"

The information "needs" include the storage and retrieval of procedures, historical data, and data on the current ship design project, and the flow of these items between engineers.

The design community as a whole does not have common procedures for the automated storage and retrieval of technical information. The entire area of developing a usable, responsive system of data handling, communication, and storage for a large organization needs to be addressed. Items of particular attention are: storing and protecting approved drawings and design items; providing communication among engineers, between engineers and managers; and standardization of data storage between departments.

3.3.2 Tools "needs"

The subject of tools includes task-specific items such as computer programs and system-wide tools such as computers.

One of the major "needs" identified was the scattering of operations among many different computers. This has resulted in different sets of software for each machine and different procedures for its use from one machine to another.

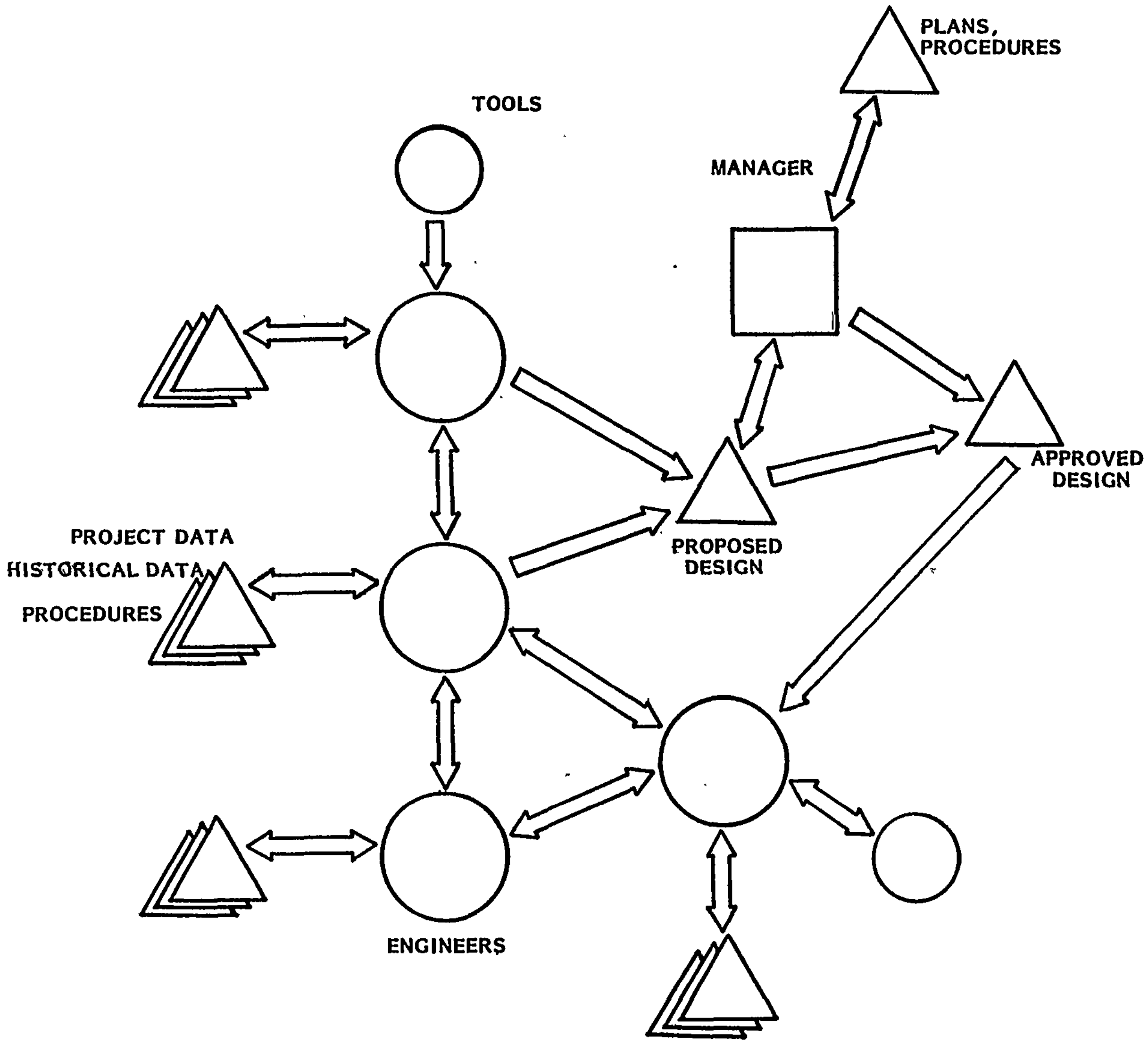

Figure 3-3. The Design Process

"Needs" in the area of specific tasks were found to be: to increase the utility of existing programs by making them more "user-friendly," and the continued development of specific programs. Another problem area was the support or maintenance of the software already developed. In short, many independent applications programs are available but other factors render them less useful than they might otherwise be.

The "needs" identified here are typical of many current design organizations. Present systems are the products of evolution and the work of many engineers working independently. The result is many independent programs working correctly, exactly as they were supposed to. The "need" or problem has only occurred because advances in technology have made much more capability feasible.

3.4 Scope

The problems identified were of the following categories:

- Insufficient or inadequate application programs,
- Overall system hardware,
- Communications among engineers,
- Ease of use of the computer system,
- Data storage, and
- Lack of common system design.

In evaluating the "needs" versus the objective of a five-to-one increase in productivity it is clear that adding one or more independent programs cannot possibly provide the necessary increase. The only course left is to tackle the system-wide areas and make use of current advances in communications, data storage and management.

It was decided that while application programs were being developed, a concurrent project would work towards a common hardware, software, and management environment.

3.5 Solutions

The major proposed solutions, or items thought to provide an overall increase in system productivity, were:

a Move all operations onto one hardware facility. This would eliminate much of the communications difficulties and differences in operations, and provide for easier maintenance and support.

l Provide a dedicated system support group for system control, software development and maintenance, and hardware operation. This would alleviate much of the burden on some design engineers and provide more reliable, consistent service throughout.

Develop an overall integration concept for data and programs utilizing current communications, data management and control capabilities. This would be the start of evolution towards an integrated system providing ease of use to the engineers.

3.6 Selection of Implementation Items

The study determined several possible improvements to the design process. As with any system, cost and other constraints determine which items are implemented.

In this case, while most engineers agree on the benefits of moving operations to one computer system, it may not be an easy thing to accomplish. Similarly, changes in the design process such as adding a software support function are also difficult to effect.

SofTech was tasked to begin work on the third proposal, to plan for an integrated system of people, software and hardware. This solution was further constrained by the requirement for rapid implementation and minimal disruption of ongoing work. This has resulted in a conceptual system design and a prototype program to improve data management and program utility. The software item is referred to as the “File Manager.”

Section 4

PROPOSED SYSTEM DESIGN

In this section the system design concept will be described. This design is an attempt to develop an integrated system of people, software and hardware. It is based upon a low-cost, low-disruption evolution from the present computer aided design environment.

4.1 Design Considerations

Before we can specify a solution to the problems some discussion of the available and forthcoming advances in CAD technology is appropriate. The field is developing so rapidly that it is difficult to implement a system before advances render it obsolete. This section will discuss some of the considerations and technological advances that must be taken into account when planning a Computer-Aided Design system.

4.1.1 Drawing Based System

In the traditional design process, based upon individual drawings, there is limited indexing and cross referencing of information. A particular drawing may be catalogued by title, drawing number and revision date. Information describing separate pieces of the ship that are shown on the drawing might be detailed in another drawing. In general, though there is no cross-referencing between drawings for a more detailed description of parts of the design (Figure 4-1).

Off-the-shelf drafting computer systems that can automate the drawing process are available. These systems do not necessarily change any of the operations; they are essentially an electronic drafting board and drawing file.

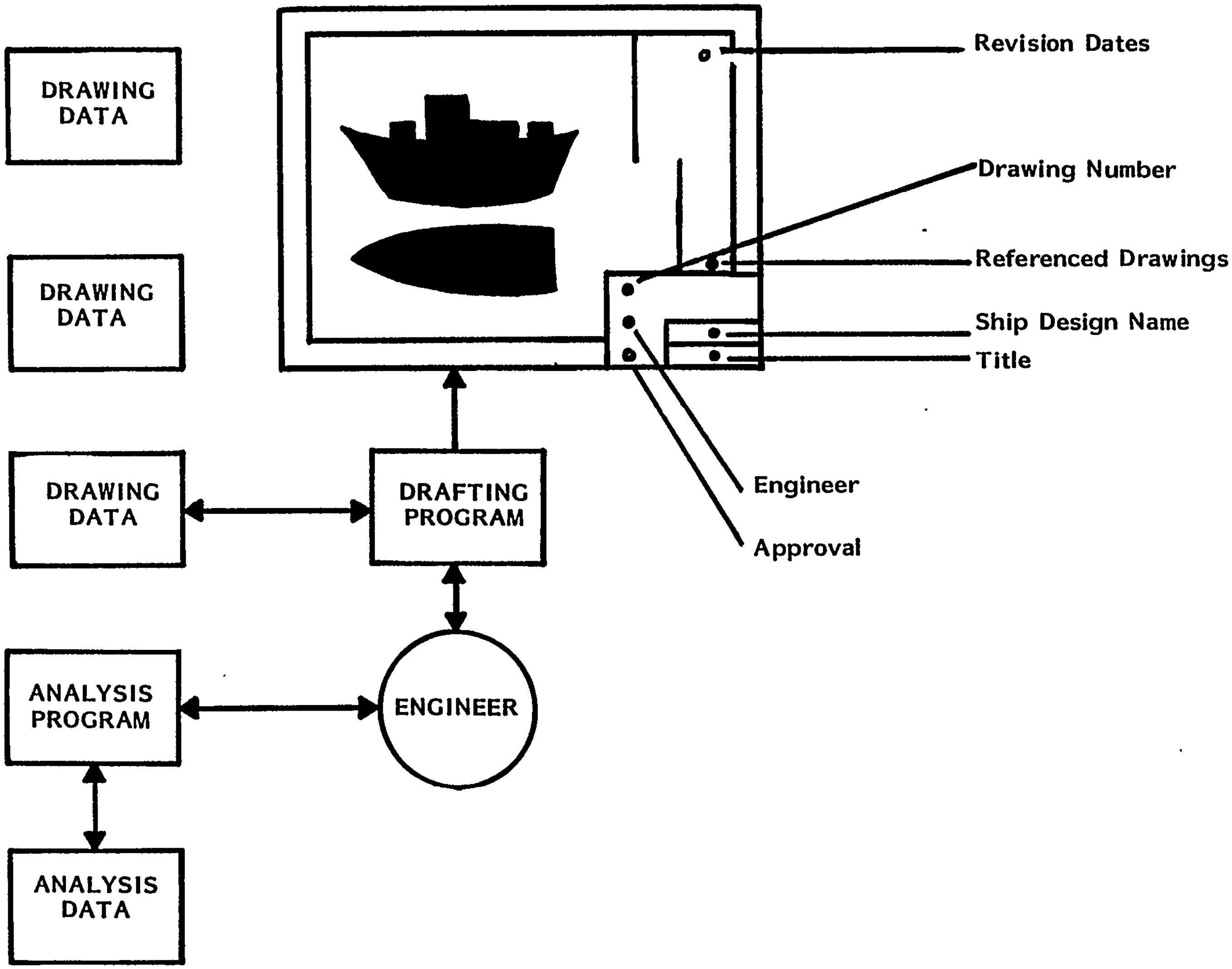

Figure 4-1. Drawing Based System

4.1.2 The Computer System as the Design Media

For the last hundred years ship designs have been performed using the drawing as the means of recording design information and communication between engineers and managers. There now exists an alternate medium to serve these functions, the computer system. While illustrations will not be replaced for the communication of concepts to individuals, it is likely that the primary means of recording information will become the computer system, since it offers instant access, change, distribution and control of information not available to a “hard” media. This transition is already underway, and when it occurs without management awareness it may be the source of problems during ship design projects.

If we accept the premise that the design will eventually be performed using the computer system as the media, we must try to determine what are the implications of this change and how they might be managed.

The properties of the computer system that provide its benefits are the same ones that may cause new areas of concern. These are: ease and speed of changing information, the ability to correlate or “track” information from many different viewpoints, the ability to use the computer as a communications center, the ability to store large quantities of information, and the ability to perform computations directly on the design data. All of these different "viewpoints" and capabilities require management. For example, the organization must control who can, or cannot, change information.

Additionally, we must always remember that the system will only do exactly what we tell it to do. Formulating the correct directions to the system is the problem.

4.1.3 Correlation of Information

The computer system provides a great deal of information storage capability. Possibly more useful than the quantities of data stored, are its ability, when working with database software, to provide many different means of indexing or accessing information. Each information item in the computer may have associated with it one or more parameters to facilitate the recalling of that stored information. When the same information is used by different people, a separate parameter may be assigned each person. We term the parameters that a person uses to organize his storage and recovery of information his Viewpoint." Potentially, there are as many different viewpoints as there are users of the information. Therefore, in the computer system we cannot simply keep track of a number of drawings, we must manage the requirement to access the information in many different fashions.

4.1.4 Directing the Computer System

The computer is a very powerful tool for engineering purposes with one major challenge. The user must direct the computer to perform his functions by specifying a series of very small computational steps. One cannot store information in the computer without specifying exactly how it will be stored and the ways it may be recalled. Database packages will help with the mechanics of this process but will not help with the specification of what is to be stored or how it will be recalled. The development of this specification requires that we decide in what units the information will be stored, or how big the groups are, by what methods may the data be recalled, and how the information is related to other stored data. This must be specified for every identifiable type of item that will be stored in the computer. Developing this description of the design information can require a great deal of effort. This description is sometimes referred to in database terminology as a "schema."

4.1.5 Computer Database Design System

Computer systems have the potential for vastly increasing the level of detail of the breakdown and storage of information. These systems differ from the "electronic drawing board" in that information about items of the ship design are stored separately. When information or an illustration is required, the desired data is selected from these separate items and presented in the desired format (Figure 4-2).

This approach has the potential for a great deal more flexibility and automation of the design effort. For instance, once the locations of hull equipments and weights are entered, this system could perform the moment calculations directly from the stored data.

4.1.6 Subdivision of the Design Data

One of the major problems in developing a CAD system is determining how to organize and subdivide the stored data. With a finer "mesh," i .e, greater detail, there is more potential for automation of functions and non-redundant storage of information, commonly termed integration. On the other hand, a coarse "mesh" provides fewer separate groups of information to manage.

Current database software enables the usage of the finer mesh from a software viewpoint. However, these databases do not solve the problems of managing the ship design information at this greater level of detail.

The main impediment to developing an integrated system is the limited techniques for managing the greater numbers of items that would now comprise the design.

4.1.7 The Electronic Design Office

If we accept the premise that the computer system will become the design media, we arrive at the concept of the "electronic design office". That is, we must implement many of the functions that we take for granted in a paper-oriented office as part of the computer system.

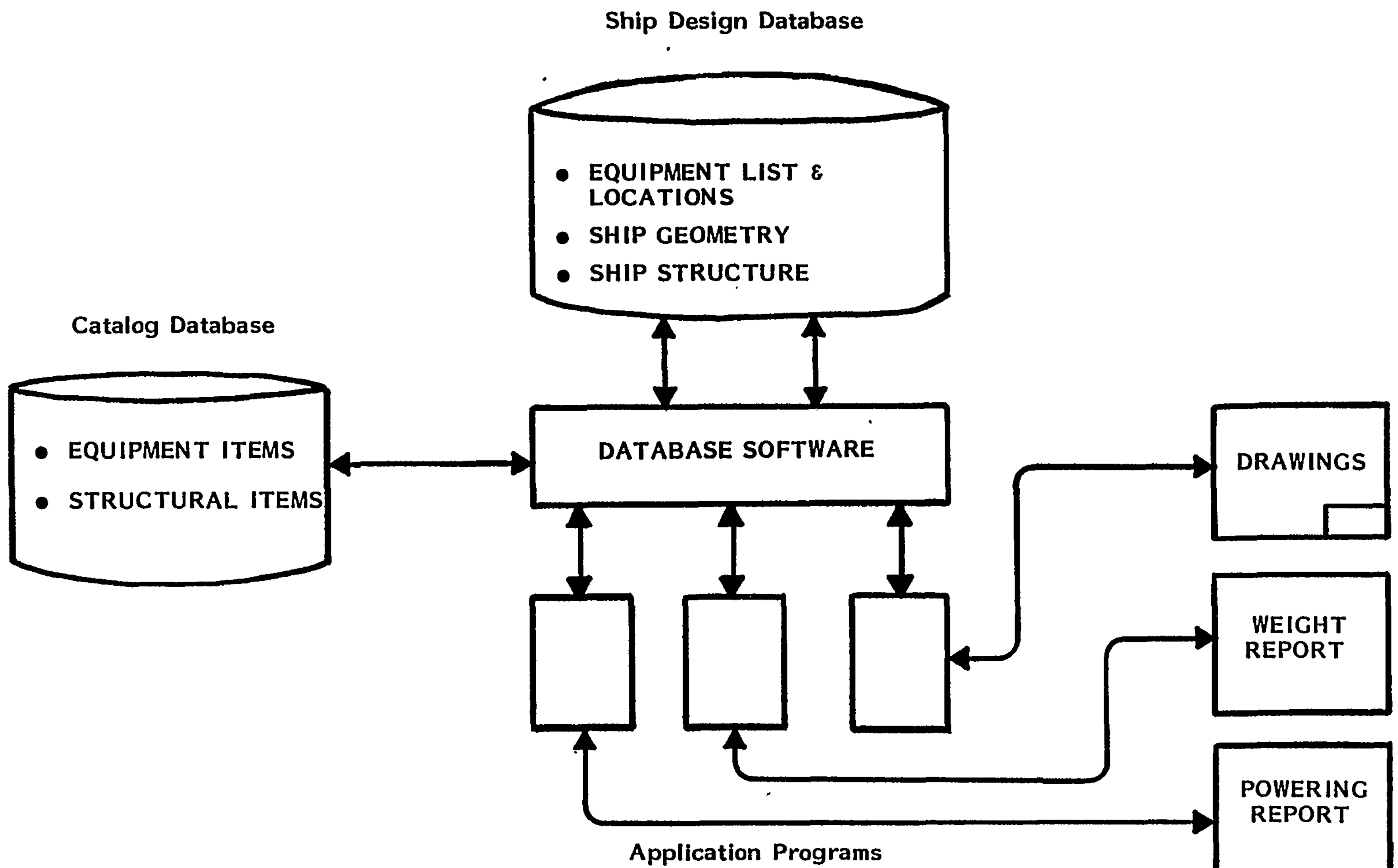

Figure 4-2. Database System

For example, as design projects and staffs have grown larger and more complex, the methods of management have not changed. In the past, design decisions could be considered, action taken, and information distributed by a small group of personnel looking over a set of drawings.

In the future this function must be performed by operating on machine-stored data, and instructing the system to perform the necessary distribution.

The current data storage systems can implement the drawing file and very importantly, track all of the drawing changes and revisions. The engineering system can be implemented so that each designer has not only his own hardware workstation, or drafting table, but his own storage areas free from outside intrusion as well.

The computers communications capability can perform the rapid distribution of new "prints" of a drawing to widely scattered designers. It may also provide the ability to hold a drafting board review over different terminals. A drawing with informal notes can be transmitted to another engineer with the same ease that formerly was used to bring it across the room.

There are a large number of functions performed in a design office that are not design or analysis. In fact, too little of the designer's time is spent in engineering. Much of their time is spent chasing down information, sitting in meetings, setting up input data and fighting unruly computers. Technology available only in the last few years can help expedite much of these efforts; except, probably, the meetings.

The proposed approach must answer "How will this be implemented?"

4.2 System Design

The system design presented here stems from the specified requirements and the aforementioned considerations. The requirements are that it provide an increase in productivity; be available soon; be low cost; be compatible with existing operations software and data, and be easy to use. The other considerations determine in which direction we would like to evolve. The system should be compatible with the present drawing-based method of design, but provide a transition towards a database concept. It should accommodate a fine data "mesh" as well. It should be able to accommodate multiple viewpoints of different personnel. It should evolve towards the "electronic design office" where the computer serves as the media for the design.

The “integration approach” is an attempt to solve this family of problems.

The drawing-based system shown in Figure 4-l provides compatibility with some of the existing software and methods. It essentially automates the drafting tasks, and may have a separate system for analysis. However, this system does not provide for evolution to a direct integration of analysis-to-design as the drawings are the only record of the design.

The database system of Figure 4-2 provides more evolutionary capability. It allows drawings to be generated from a central record of the ship design. In fact it accomplishes all of the desired functions, but only theoretically. The performance and management problems with systems of this type have limited their successful use to very small operations.

The proposed system is shown in Figure 4-3. Essentially this uses the same element as the database system. We will store information about the ship, not records of lines that describe the ship's components. The difference is that the database, and the control of the data is distributed to match the project structure.

The data is broken into the fine "mesh" suitable for highly integrated programs and data access, but it is grouped in sets small enough to be manageable. This approach is feasible because in the design process there is very little requirement for great detail other than to the staff directly responsible for a segment of the design. The distribution of the database in this fashion also removes many of the

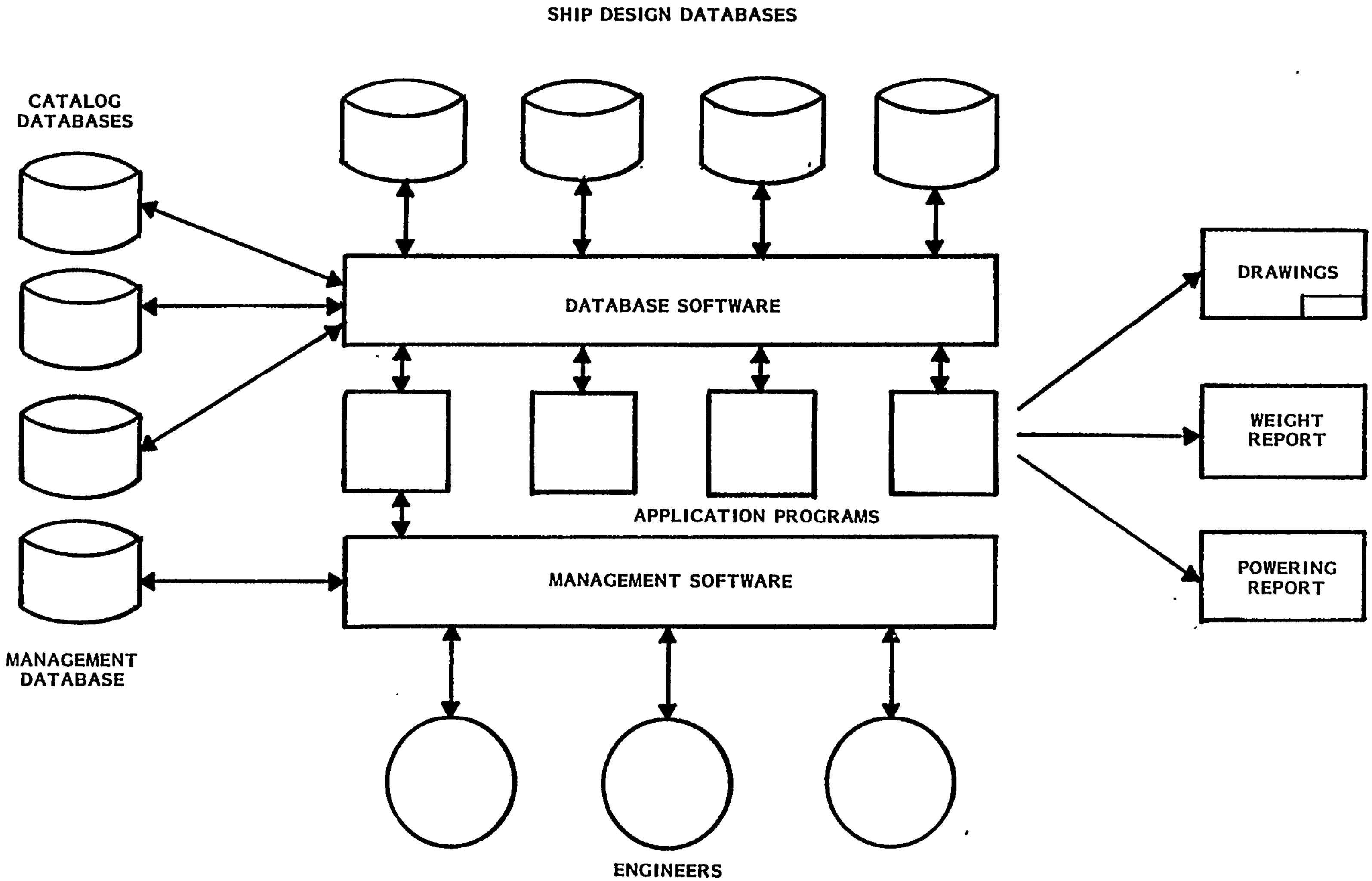

Figure 4-3. Proposed System Design

physical performance limitations. In addition, the system includes a management system to keep track of this distribution, and to provide for the essential transfer of information between groups.

4.2.1 Data Structure

The tradeoff presented is that of a fine "mesh" or subdivision of data items for program integration and flexibility versus a coarser "mesh" that is familiar to engineers and is easier to manage.

The selected integration approach is to have a different level of subdivision for management purposes from that used for the software data access. The management subdivision will be much the same as the present drawing level of detail. The software storage of data will start off with the current file access methods and evolve toward a database system.

The key to understanding the approach is that the physical implementation of the information on the computer does not have to match the user's perspective of that information. Although an engineer may wish to see all the ship's geometry information at one time, that does not require that all the information be stored in the same place, or even in the same manner. What is required is that the engineer have an access-method to the data that will yield the desired result. Allowing different access methods or viewpoints to the same information gives us the flexibility to have both the fine and the coarse mesh we need for the design process.

The approach of distribution of data and its control, while maintaining a separate management system, provides the capability to transition smoothly from current software to the "electronic office." The management system may be implemented by treating each type of present data file as a separate database or database segment. The existing data access methods can be utilized until the requirement for a finer "mesh" or other needs dictate a change. Thus, existing data access methods can be used side-by-side with newer database techniques, with the management system handling the switching between them.

Perhaps an analogy to a large engineering library will convey the concept more clearly. If the library has only one librarian, and the books are cataloged by a system known only to that librarian we have the case of a central database. If the librarian is very, very fast users may get what they need. If the librarian is not fast, there will be undesirable delays.

The present system is that of having many separate libraries. Each has books on one or more subjects, and overlaps exist. Moreover there are no librarians, only users of the different libraries who may or may not be available to help others.

The proposed system includes the establishment of separate libraries and cataloging them, but keeping **individual indexes** for each one. A central librarian directs the user to a librarian in charge of the particular section he requires. From then on the user will work directly with that local librarian. In our case we follow the same sequence for storing information as well.

4.2.2 Program Structure

The conceptual design is a system of computer programs, engineers, databases and management.

The computer programs of the system design would be similar to those currently in use. The trend has been for programs to increase in size and complexity. This has come about mostly because of the difficulty of data access and management. The engineer pulled in an entire "management unit" of information and performed his operations on it.

The conceptual system design calls for the development of smaller programs performing one or two functions. These programs are easier to implement with database technology and may be "strung" together to achieve the same results as the larger programs, if required.

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4.2.3 Engineers Viewpoint

The proposed system will allow the engineer to function in the same manner as they do now, with the substitution of the computer terminal for the drafting board.

The engineer will be responsible for individual tasks. These will be accomplished by design, analysis or drafting programs. The engineer will have complete control over his information, and will be able to permit or restrict access as he desires.

4.2.4 Design Managers

The project managers will be responsible for approving design information stored on the computer and for directing analyses or changes to the design. Therefore, the system must be able to record and "freeze" information on approval. There must be the computer equivalent of setting a "baseline" of a design.

Change directives must also be coupled with the design data. If a change based upon a drawing or report is directed, that particular collection of data must not vanish when the engineer performs his next update. The recordkeeping that goes along with the drawing system must be implemented on the computer.

4.2.5 Data Administration

With the development of software to manage data storage, a data administration function must be initiated. The subdivision of data, its place in the databases, and its retrieval methods cannot be readily distributed.

This function is analogous to the setting up of the central librarian, who in turn will hire and manage the supporting specific librarians.

4.2.6 Program Development and Maintenance

Developing programs under this sytem should be simpler because of the separation of data access methods from the programs. By referring to the data administration documentation, programs may call previously set up data access methods.

As the data access methods are central to the entire system, control will have to be exercised over their operation. Independent software developments must be checked for authority, security and project control before allowing data to be changed.

4.3 File Manager

The "File Manager" is a program being developed to aid in the use of the computer aided design program and to help manage the design data. Its objective is to remove the need to know any specific computer language or operations from the engineer . It is designed to be the first step toward the management part of an integrated system of programs and data. The first "BUILO" of the program is now in operational evaluation and test. updates and extensions are planned to result in "BUILD TWO" by the Spring of 1983.

The present environment utilizes data files stored by different naming conventions on each computer. For example, some conventions limit the user to a seven-letter filename. The overhead involved as the engineers learn the computer file manipulation commands and track their files has become a noticeable problem.

4.3.1 File Manager Data Structure

The File Manager (FM) provides a structure to aid the engineer in the storage and recall of ship design information. The database is divided into ship design projects, ship design variants inside a project, and files that are parts of a particular design. Files that are part of a design are further categorized by their approval status. They may be approved files, i.e, files that constitute a design baseline. Other classifications include "past approved files" and proposed files representing previous baselines and the target for the next baseline, respectively.

There will also exist “private files” directly under the control of the design engineers as part of the design. One engineer may work on many projects or designs, but a particular file of information will only be associated with one design (Figure 4-4). The File Manager will manage information about existing files at a management level. As new software is developed the file manager will be extended to include the separation of programs from data access routines.

4.3.2 File Manager Data Handling

The file manager will provide each engineer with the ability to add, delete, rename and search for files by using simple commands selected from a menu. For example, the engineer may request a list of all files owned by an engineer, or all files of a certain type, or all files written on a specific date.

More importantly, the system will deal in terms that have significance to the engineer. The system will remove all "computerese" from the interaction with the user. It will at the same time permit sophisticated operations to be performed.

4.3.3 File Manager Program Interface

The file manager will provide a means for the engineer to initiate a programs operation by choosing simple commands from a menu presented to him. The system will ensure that only the correct type of files are used as input to each program, and that they are of the same design as is currently being performed.

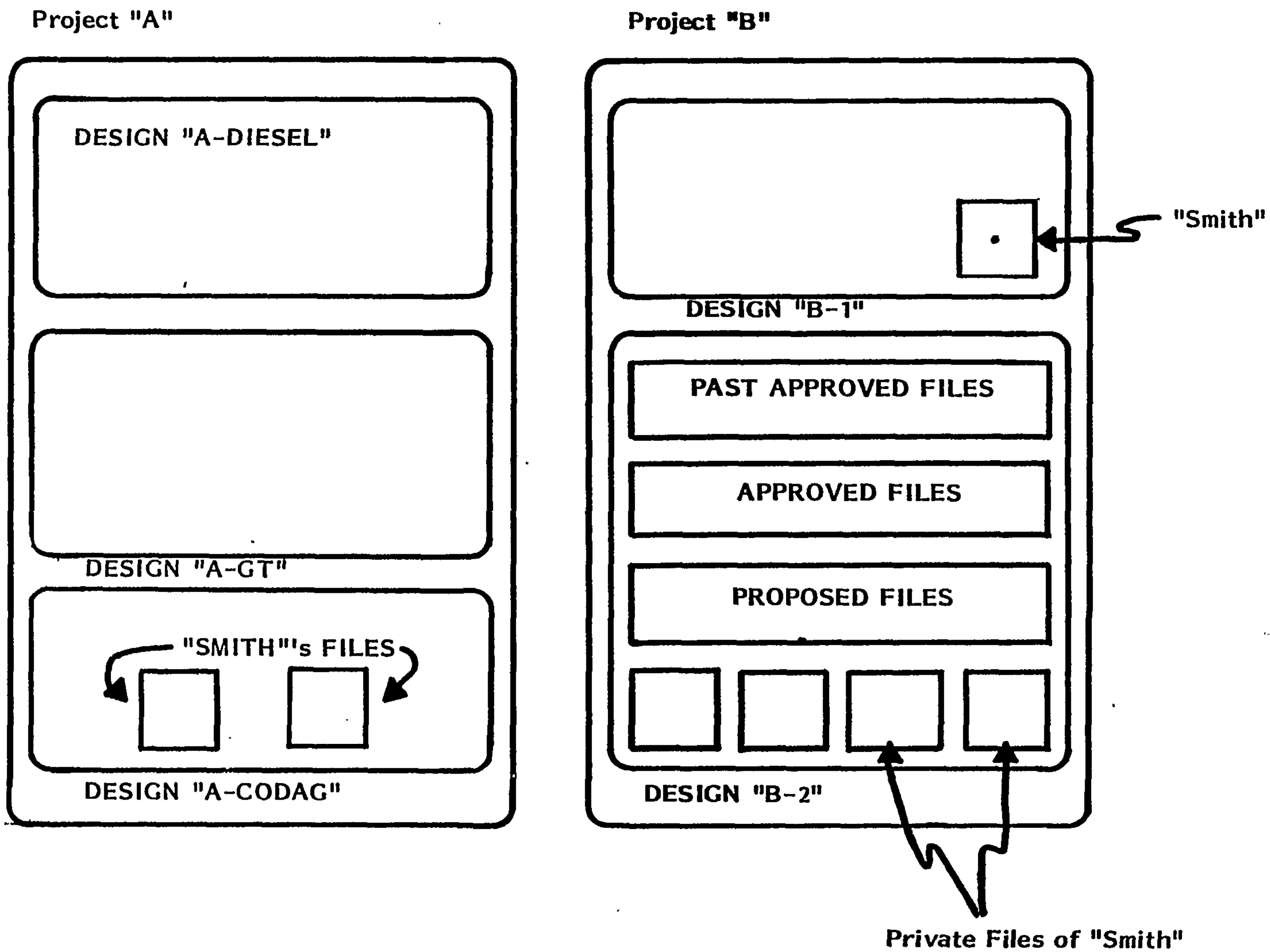

Figure 4-4. File Manager Data Structure

Section 5

SUMMARY

The conclusions of our study are that in some ship design environments the best return on an investment in computer aided design technology may be in integrating existing software. This is to some extent dependent upon the size of the design organization, as smaller groups do not have the same management problems.

The integration approach, or conceptual design offers a transition from current methods towards a database system or "electronic design office" (Figure 5-l). The approach will smooth the transition, allow easier acclimation of users, and more gradual cost of implementation. It will lessen the work involved by allowing us to learn as we go along instead of plunging headlong into a major CAD system re-write.

We believe that a similar approach toward increasing productivity or profitability may be applicable to a number of other design or manufacturing environments, where compatibility with existing operations, evolution towards advanced systems and gradual implementation are important considerations.

- Organizations must focus on the best return on their CAD investment.

- The trend is towards the **Electronic Design Office", the computer is the design media.

- It is possible to plan a smooth transition from current systems to the "Electronic Design Office"

Figure 5-l. Summary

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